TECHNICAL MANUAL No. 1-231

WAR DEPARTMENT,
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ELEMENTARY WEATHER FOR AIR CREW TRAINEES

SECTION I

GENERAL

1. Importance of weather to flying.—*a.* Most aircraft accidents may be attributed to an error, either in judgment or in technique, made by the air crew. Whenever an airman must make a decision concerning a situation which involves adverse weather conditions, the correctness of his judgment will depend to a great extent upon his accurate appraisal of the existing weather conditions and their future trend.

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In certain types of weather, flying may be quite safe, whereas in other types it may be highly dangerous. The study of weather is the study of the atmosphere, and the operation of aircraft depends to a very large extent upon atmospheric conditions. It is therefore highly important that all air crews receive in their training as much knowledge of weather as possible. The best possible knowledge of weather by both air crews and ground personnel in charge of flying can go a long way toward the elimination of accidents, thereby increasing effectiveness of military air operations.

b. Only a part of weather can be taught out of a book. Book learning and classroom instruction are invaluable aids to experience but are only aids. Experience and the ability to interpret observations in terms of flying conditions constitute one of the airman's most valuable assets. This experience can be gained only by daily practice in "keeping an eye on the weather" coupled with study of the science of the weather. The airman should endeavor every day to perfect his ability to understand weather.

2. Safety in wartime and peacetime flying.—In time of peace, military flying is done for only one purpose: to build up and to maintain an air force which can be used effectively as a military arm if war should come. During war, tactical units in the air force are used to attack the enemy and to defend against attack. The difference in reasons for flight in war and peace requires a difference in policies regarding safe flight in bad weather. In peace, safety is the primary consideration. In war, the performance of a military mission may be far more important than safety from weather hazards. In order to take care of both these situations it is highly important that the air crew and ground personnel in charge of flying have a practical knowledge of weather. The successful performance of a military mission is obviously impossible if the air crews cannot get safely through bad weather encountered en route. In either peace or war it does not make sense to lose air crews and airplanes simply through ignorance of weather. Peacetime flights are made only when the danger from bad weather is considered negligible. Wartime flights are made whenever necessary for the safety of the Nation. The air crews which get through safely, perform their mission effectively, and return to their bases are the ones that can remain in action and be of the greatest value to their country. It has been found in war zones that air crews remain in action when they handle their airplanes well and use their weather knowledge effectively.

3. Weather course for air crew trainees.—*a.* It is not the purpose of this weather manual to enable air crew trainees to be weather

forecasters. It is necessary that members-to-be of the air team learn how to obtain and use effectively the weather information available and how to recognize and report weather phenomena. Air crew training in weather includes the following:

(1) Types of weather are extremely variable and no set of rules will tell an air crew how to fly in all types of weather. It is necessary, therefore, that members of the air crew learn the basic principles of weather. Only when members concerned *understand* why a certain type of weather is found will they know how they may or may not fly through it in order to avoid danger.

(2) It is important that an air crew trainee understand the specialized weather terms which are necessary to describe weather conditions; otherwise, valuable weather information available to him will be useless.

(3) In the performance of military air operations, certain types of weather may prove favorable or unfavorable; for example, clouds may hinder aerial observation of ground movements or they may serve to shield flight maneuvers over the enemy. Clouds and visibility are most important in this respect. It is intended that the air crew trainees learn how to make the best use of weather encountered in flight in order to perform their mission most effectively.

(4) In order to maintain a useful weather service, information as to atmospheric conditions in surrounding regions must be obtained. If some of this region is in enemy territory, information can be obtained only from our air crews. It is one of the fundamental purposes of the weather course to teach members of the air crew how to make weather observations in flight which will be of value to a forecaster and to other air crews.

b. The course in weather for air crews is in two parts. This manual is arranged for use in primary training schools and covers material in observational weather. A study of the principles of weather will be taken up in basic training schools.

4. Weather services for military aviation.—*a.* In the continental United States, the Army Air Forces weather services use the observational and communication facilities of the United States Weather Bureau and the Civil Aeronautics Authority for gathering data upon which to base weather analyses and forecasts. These facilities include a network of observing stations along the established air routes which report their weather hourly by teletype and a network of stations scattered over the entire country which report every 6 hours by telegraph or teletype. At military air bases, weather fore-

casts based upon the analysis of these reports are issued by the base weather office and used as a basis for clearing flights. At civilian fields where teletype service is available, the airways forecasting service of the Weather Bureau may be used, but weather maps and discussion with the forecaster will be available only at the larger fields.

b. Outside the continental United States, the Army Air Forces weather services maintain weather stations in all theaters of operation. Where established facilities are available, the Army Air Forces weather service cooperates with other arms and services in the particular area in making and distributing weather observations, distribution of reports being made by teletype every 2 hours whenever possible. In the actual combat zone, observations are made by various Army organizations and distributed by radio or other communication channels. Forecasts are issued by the field weather units.

c. The importance of teletype weather reports is obvious. Because of this importance, considerable space in this manual is devoted to decoding and interpretation of teletype weather messages.

Section II

AIRWAY WEATHER OBSERVATIONS AND REPORTS

5. Organization of airway teletype report.—Figure 1 shows an example of a complete airway teletype weather report. Placement of each item of information and the arrangement into logical groups are indicated. The next five paragraphs are devoted to explaining in a simplified form methods of observing and reporting by code each of these items, arranged by the groups indicated in the figure.

6. Group 1: Identification of report.—*a. Station designator.*—Each airway and field weather observation station has a set of call letters for identification. The station making the observation places its call letters at the start of each report.

b. Classification of report.—The classification of flight conditions, as influenced by weather, is indicated here. If navigation may be safely maintained by keeping watch of the ground, the classification

will be contact, designated in the report by the letter C. If an instrument approach is required for locating the landing field, instrument rules apply and this will be designated in the report by sending the letter N. If the ceiling or visibility or both are so limited that landing or take-off is extremely hazardous, the field is classified as restricted and this would be reported by sending the letter X.

(1) The letter C indicates *contact* flight rules—Ceiling 1,000 feet or more *and* visibility 3 miles or more.

(2) The letter N indicates *instrument* flight rules—Ceiling below 1,000 feet but not below 500 feet *or* visibility below 3 miles but not below 1 mile.

(3) The letter X indicates the field is *restricted* for landing or take-off—Ceiling below 500 feet *or* visibility below 1 mile.

NOTE.—If either the ceiling or visibility falls below the minimum for one of the classes described above, the weather report will be given the next lower classification. For example, within control zone, ceiling 800 feet, visibility 4 miles, the operator should report Class N instead of class C. Some airports have higher limits, especially where there are tall obstructions near the airport.

c. Type of report.—The only reports with which air crew trainees are concerned are record observations and special observations. Record observations are those sent at regular intervals, every hour on the half hour. No designation in the report is used to indicate a record observation, since most reports are of this type. If a crucial change in the weather has occurred, special reports are sent out at the time of occurrence. Special reports are indicated by the abbreviation SPL.

d. Time of report.—In any report sent out other than at the regular hour reserved for record observations, the time of the report is indicated immediately following the type of report. The 24-hour clock is used with local war time. The following examples illustrate how time reports are made:

(1) 9:15 AM Eastern War Time	0915E
(2) 12:05 AM Pacific War Time	0005P
(3) 2:40 PM Mountain War Time	1440M
(4) 11:50 PM Central War Time	2350C

WA N SPL 1624E E30 ⊕15⦶ 2V TRW—BD— 152/68/60—↘22+ ↑1618E/996/+⊕NW

Group	Symbol	Element
Group 1. Identification	WA	Station designator
	N	Classification of report
	SPL	Type of report
	1624E	Time of report
Group 2. Condition of the sky	E30	Ceiling
	⊕15⦶	Sky condition
Group 3. Special weather conditions	2V	Visibility
	TRW—	Precipitation
	BD—	Restriction to visibility
Group 4. Properties of the air	152/	Barometric pressure
	68/	Temperature
	60	Dew point
Group 5. Miscellaneous data	—↘	Wind direction
	22	Wind speed
	+	Wind character
	↑1618E/	Wind shift
	996/	Altimeter setting
	+⊕NW	Additional remarks

FIGURE 1.—Arrangement into groups of related weather in airway teletype weather report.

7. Group 2: Condition of sky.—*a. Ceiling.*—(1) Ceiling may be thought of simply as the height of the base of the clouds in feet above the level of the station. The following reservations should be noted:

(*a*) Clouds which cover five-tenths or less of the sky do not form a ceiling. Under these conditions the ceiling will be unlimited.

(*b*) If the ceiling is 10,000 feet or higher, it will be reported as unlimited.

(*c*) If several layers of scattered clouds are present, the ceiling will be the lowest height at which the clouds at or below that level cover more than five-tenths of the sky. For example, if there are three layers of clouds in the sky, the lowest layer covering three-tenths of the sky, the middle layer covering four-tenths of the sky, and the

top layer being a complete overcast, the ceiling will be at the level of the middle layer as the total cloudiness of this layer and the one below is seven-tenths, while at any level below this the cloudiness is only three-tenths. Had the middle layer covered only one-tenth of the sky, the ceiling would have been at the upper overcast layer, as the total cloudiness at any level below would have been less than five-tenths.

(*d*) If fog, dust, blowing snow, blowing dust, blowing sand, and other obstructions prevent observation of the sky and reduce the visibility to less than 1/5 mile, the ceiling is reported as zero.

(2) Three methods may be used by ground observers to measure ceiling height:

(*a*) In the first method the observer on the ground notes the intersection of the clouds with prominent objects such as towers, buildings, or mountains, and the ceiling is then observed directly.

(*b*) Ceiling may be determined during daylight hours by use of ceiling balloons. These balloons are usually inflated with hydrogen in a standard way so that they will rise at a known rate of speed. The ceiling will then be measured by the amount of time required for the balloon to disappear into the clouds.

(*c*) For accurate determination of the height of the ceiling at night, a ceiling projector (a form of electric searchlight) is employed to throw a spot of light on the under side of the cloud layer. The projector shines the light vertically and the ceiling is determined by measuring the angular elevation of the light spot from a standard distance.

(3) Ceiling is reported in hundreds of feet in the teletype weather report. If the ceiling is 8,500 feet, the report will carry the number 85. If the ceiling is 50 feet or less, it will be reported as zero and the figure 0 sent on the report. If the height is estimated rather than measured, the letter E precedes the elevation. For example, if the ceiling is estimated at 600 feet, the report will be E6. If the ceiling is unlimited, this element of the report is omitted.

b. *Report of cloudiness*.—This consists of two phases, the first dealing with the types of sky conditions and the second with the height of the cover above the surface of the earth.

(1) *Types of sky conditions*.—(*a*) In making observations and reports the following symbols and words are used to describe the types of sky:

1. ○ Clear; no clouds or less than one-tenth of sky covered by clouds.

2. ⦶ Scattered; one-tenth to five-tenths, inclusive, of sky covered by clouds.

3. ⦶ Broken; more than five-tenths but not more than nine-tenths of sky covered by clouds.

4. ⊕ Overcast; more than nine-tenths of sky covered by clouds.

(*b*) These observations are always taken at a point from which the entire sky may be viewed, and then the number of tenths of sky covered by the clouds is reported in one of the above terms as based on the entire dome of the sky.

(2) *Height of sky cover.*—Sky cover generally is classified by height into two groups:

(*a*) High clouds—those 10,000 feet or more above the surface.

(*b*) Low clouds—those less than 10,000 feet above the surface.

(3) *Complete cloud report.*—With the above symbols, two separate layers of clouds may be reported in this section of the report. If one layer of the clouds is high and the other low, the slant mark will follow the symbol for the high layer. A single symbol followed by a slant mark indicates that the clouds are high. If the slant mark is missing, the clouds are all low. If there is a layer of scattered clouds below the ceiling, the height of that layer will be indicated before the "scattered" symbol in hundreds of feet except when there are two layers of scattered clouds, in which case only the height of the lower layer will be shown. The following examples will illustrate the methods of reporting various types of cloud decks:

(*a*) 30⦶⦶ reports a 3,000-foot ceiling, broken and lower broken clouds. Both of these layers are below 10,000 feet and the lower layer is at 3,000 feet. 30 indicates that the ceiling is the base of the lower layer of broken clouds. The word "broken" means that the layer covers more than five-tenths of the sky. The upper layer of broken clouds is at a height somewhere between 3,000 and 10,000 feet.

(*b*) 30 ⊕/⦶ reports a 3,000-foot ceiling, high overcast and lower broken clouds. The overcast layer is at 10,000 feet or above and the broken layer which determines the ceiling is at 3,000 feet.

(*c*) 30⊕15⦶ reports a 3,000-foot ceiling, overcast, and with lower scattered clouds at 1,500 feet. The overcast layer is at 3,000 feet.

c. Visibility.—Visibility is the mean greatest distance toward the horizon that prominent objects such as mountains, buildings, towers, etc., can be seen and identified by the normal eye, unaided by optical devices; this identification must be possible over a range of more than half the horizon.

(1) Visibility is measured by visual observation, noting the distance at which objects blend into their surroundings. Each observation station has on hand a table of checking points showing the distances of objects surrounding the station. At night, unfocused lights are observed as well as prominent objects against the sky.

(2) Visibility is reported directly in miles and fractions of miles. A fluctuating visibility is indicated by entering the letter V immediately after the report. If the visibility is 10 miles or greater, no report of visibility will be made; it may be considered unlimited. These examples illustrate the reporting of visibility:

(*a*) 5 indicates a 5-mile visibility.

(*b*) 11/4 indicates a 1¼-mile visibility.

(*c*) 21/2V indicates a 2½-mile visibility, fluctuating about this value.

8. Group 3: Special weather conditions.—This group includes reports of all thunderstorms, squalls, precipitation, and restrictions to visibility. Descriptions of each condition and the codes for reporting are given below.

a. Thunderstorm (reported T, T+).—A thunderstorm is reported whenever thunder can be heard. If the storm is especially severe, wind speeds of over 40 miles an hour and incessant loud thunder, the storm is classified as heavy (reported T+).

b. Rain (reported R−, R, R+).—Rain is a fall of liquid drops of water having a diameter greater than $\frac{1}{50}$ inch. Rain may be classified as light, moderate, or heavy (reported R−, R, R+ respectively), depending upon the rate of accumulation of water in inches or fractions of inches in a given time.

c. Freezing rain (reported ZR−, ZR, ZR+).—Freezing rain is rain which freezes instantly upon striking objects in the open. It is classified in the same manner as rain.

d. Drizzle (reported L−, L, L+).—Drizzle is a fall of very fine drops of liquid water. These drops seem to float in the air. Their diameter is less than $\frac{1}{50}$ inch. Drizzle is classified as light, moderate, or heavy by the degree to which it alone limits the visibility not by the rate of accumulation of water on the ground.

e. Freezing drizzle (reported ZL−, ZL, ZL+).—Drizzle which freezes instantly upon impact with objects in the open is a freezing drizzle. It is classified in the same manner as drizzle.

f. Snow (reported S−, S, S+).—Snow is a fall of white or translucent ice crystals usually in branched hexagonal shapes. Snow is classified as light, moderate, or heavy by the degree to which it alone limits the visibility while falling.

g. Sleet (reported E−, E, E+).—Sleet is fall of transparent, globular grains of ice ranging from $\frac{1}{25}$ to $\frac{4}{25}$ inch in diameter. It is formed by the freezing of raindrops before they reach the ground. Sleet is classified as light, moderate, or heavy, depending upon the rate of accumulation on the ground.

h. Hail (reported A−, A, A+).—Hail is fall of ice balls or stones with diameters ranging from 1/5 inch to 2 inches or more. They may be either quite transparent or composed of alternate layers of clear and opaque ice. Hail occurs almost exclusively in violent and prolonged thunderstorms. It is classified as light, moderate, or heavy, depending upon the rate of its accumulation on the ground.

i. Snow pellets (reported SP−, SP, SP+).—Snow pellets are white opaque grains having a snowlike structure. They are usually crisp and easily compressed. They rebound and often burst when striking hard ground. Snow pellets fall almost exclusively in showers.

j. Small hail (reported AP−, AP, AP+).—Small hail is a fall of semitransparent grains of frozen water, usually with a soft center and a thin, wet layer of ice around the outside, which give a glazed appearance. It is classified in the same manner as hail.

k. Showers (rain reported RW−, RW, RW+; snow reported SW−, SW, SW+).—Showers of either rain or snow occur when the precipitation is of a highly variable character, alternately starting and stopping. They are classified in the same manner as rain or snow, respectively.

l. Squalls (rain squalls reported RQ−, RQ, RQ+; snow squalls reported SQ−, SQ, SQ+).—Squalls are reported when precipitation is accompanied by gusty winds. They are classified as light, moderate, or severe, depending upon the intensity of the wind gusts.

m. Dry haze (reported H).—Haze is a suspension in the air of extremely fine particles of dust or other particles which may quite appreciably reduce the visibility. It gives a characteristically dirty appearance to objects at a distance.

n. Damp haze (reported F− −).—Damp haze is a suspension in the atmosphere of very fine water droplets or hygroscopic particles. Damp haze is similar to a light fog except that the particles are usually finer and more highly dispersed. The visibility is usually greater than 1¼ miles.

o. Fog.—Fog is a suspension in the air of water particles condensed from the vapor state. It is classified in intensity by the degree to which it limits visibility.

(1) *Light fog* (reported F−).—Visibility 5/8 mile to 7 miles.

(2) *Moderate fog* (reported F).—Visibility 5/16 to 5/8 mile.

(3) *Thick fog* (reported F+).—Visibility 1/5 to 5/16 mile.

(4) *Dense fog* (reported FF).—Visibility less than 1/5 mile.

p. Ice fog (reported IF−, IF, IF+, IFF).—Ice fog occurs when the particles are ice instead of liquid water. Ice fog is classified by intensity, the same as fog.

q. Ground fog (reported GF−, GF, GF+, GFF).—Ground fog occurs only in a shallow layer so that the sky is visible from the ground. It is reported in the same way as fog.

r. Smoke (reported K−, K, K+).—When smoke reduces the visibility, it is reported as light, moderate, or thick, depending upon the degree to which visibility is reduced.

s. Dust (reported D−, D, D+).—When dust is distributed in the atmosphere it is reported as light, moderate, or thick, depending upon the degree to which visibility is reduced.

t. Blowing dust (reported BD−, BD, BD+).—When dust is picked up from the surface and blown about in clouds or sheets at low levels, it is reported in the same way as dust.

u. Blowing sand (reported BN−, BN, BN+).—When sand is picked up locally by the wind and blown about in thick concentrations, it is classified in the same way as dust.

v. Blowing snow (reported BS−, BS, BS+).—When the snow is not actually falling but is picked up from the surface and blown about in clouds or sheets, reducing visibility, it is reported as blowing snow. It is classified in the same manner as snow.

w. Drifting snow (reported GS−, GS, GS+).—Drifting snow is similar to blowing snow except that it remains close enough to the ground for the sky to be seen. It is classified in the same manner as snow.

9. Group 4: Properties of air.—*a. General.*—This group may easily be identified in the report by three groups of figures separated by slant marks such as 091/45/53. The first of these is the barometric pressure, the second is the temperature of the air, and the third is the dew point.

b. Barometric pressure.—(1) Pressure may be defined as force exerted on a unit area of surface by a fluid under compression. At sea level the atmosphere exerts a pressure of about 15 pounds per square inch. The atmosphere may be thought of as a sea of air with the land and ocean surfaces at its bottom. In the same way that a sea of water exerts an increasing pressure with depth, the pressure exerted by the atmosphere is greater at low elevations than in the upper atmosphere. The pressure of the atmosphere is a result of the weight of the air above that point. With increasing elevation the amount of atmosphere above a specified point will decrease and, therefore, the pressure in the atmosphere consistently decreases with increasing height.

(2) The pressure exerted by the atmosphere at sea level does not remain constant. It has been found that variations of as much as 4 percent above the average and 5 percent below will occasionally be

found. Certain characteristics of barometric pressure have been found to accompany special types of weather phenomena. For this reason, weather forecasters require a knowledge of the pressures that exist over large areas on the map. Barometric pressure is included in practically every type of weather report sent out.

(3) In order to facilitate their calculations, weather men for several years have substituted a unit called "millibar" for inches of mercury. Normal atmospheric pressure at sea level is 29.92 inches of mercury or 1,013.2 millibars. The pressure is given in units and tenths of a millibar, but in reports only the last three digits of the complete pressure number are sent. For example, a pressure of 1,008.8 millibars would be reported 088 with the decimal point left out. A pressure of 991.5 millibars would be reported 915. There will be no confusion as to whether the pressure is above or below 1,000 if one remembers that the pressure practically never drops below 970 or rises above 1,050 millibars. A report of 751 could not mean a pressure of 1,075.1 (this would be an impossibly high value) but would indicate pressure of 975.1 millibars.

c. Temperature.—Temperature of the surface air is measured by means of an ordinary thermometer kept in the shade. Temperature reports are made directly in degrees Fahrenheit in English-speaking countries, elsewhere in degrees centigrade.

d. Dew point.—Dew point is an indication of the amount of water vapor in the air. It is defined as that temperature to which the atmosphere must be cooled before water vapor will condense from the air. The dew point is a very important factor in predicting the formation of fog, clouds, and precipitation, as all of these form by condensation of water from the air. The dew point is a temperature (sometimes called dew point temperature) and is measured and reported in the same units as temperature.

e. Complete report of properties of air.—The following examples illustrate the decoding of this group:

	Report	*Pressure*	*Temperature*	*Dew point*
(1)	891/44/44	989.1 mb.	44°F.	44°F.
(2)	091/95/76	1,009.1 mb.	95°F.	76°F.
(3)	452/−20/−35	1,045.2 mb.	−20°F.	−35°F.

10. Group 5: Miscellaneous data.—*a. Winds.*—Wind may be defined as air moving horizontally across the earth's surface. Winds are found throughout the atmosphere, both at the surface and at upper levels. Reports of winds include an indication of both direction and speed of the air movement.

(1) The direction of a wind is that *from* which it is blowing. For instance, air movement *from* the northeast toward the southwest would

be a northeast wind. Sixteen points of the compass may be used—north, north-northeast, northeast, east-northeast, east, etc. Airway teletype reports indicate wind direction by means of small arrows which may be thought of as flying with the wind. Only eight arrow symbols are found on teletype machines, so it is necessary to use two arrows to indicate odd directions. The following examples illustrate the method of reporting wind direction:

Wind		*Report*
(*a*) North		↓
(*b*) North-northeast	(Combination)	↓↙
(*c*) Northeast		↙
(*d*) East-northeast	(Combination)	←↙
(*e*) East		←

(2) Wind speed is measured and reported by airways weather stations in miles per hour. Another system of reporting wind speeds, the Beaufort scale (see sec. III), is used by Weather Bureau stations in the 6-hourly reports used for forecasting purposes. The wind speed in miles per hour is entered directly after the wind direction arrow, or arrows in the airway teletype report. If the wind is of a gusty character it may be indicated by the addition of a plus or minus sign immediately after the wind speed. If the peak speed of these gusts is 25 miles per hour or greater, the gusts are said to be "strong" and are indicated by a plus sign; if the peak speed is from 19 to 24 miles per hour, they are said to be fresh and are indicated by a minus sign. The absence of a plus or minus sign indicates the wind is steady. If the air is calm, the letter C is sent alone.

b. Wind shifts.—If there has been a pronounced shift in the wind direction which may have special significance, it will be reported immediately following the other wind data. This report consists of a wind arrow (to eight points of the compass) showing the former direction and the time that the shift occurred. Intensity of the shift may be indicated by the addition of a plus or minus sign, minus indicating a mild shift, no sign a moderate shift, and a plus sign a severe shift.

c. Complete wind data.—The following examples illustrate the decoding of wind data in the teletype report:

	Report	*Wind data*
(1)	↑5	South wind, 5 miles per hour.
(2)	↓↙25+	North-northeast wind, 25 miles per hour, strong gusts.
(3)	↘25+ ↑1634C+	Northwest wind, 45 miles per hour, strong gusts, wind shifted severely from the south at 4:34 PM Central War time.
(4)	C	No wind (calm).

d. Altimeter setting.—The altimeter on an airplane is a sensitive aneroid barometer or pressure measuring instrument. Its principle of action depends upon the decrease of pressure with elevation. Where the pressure is high, as at sea level, the altimeter reads low elevation; and at high elevations, where the pressure is low, the altimeter indicates high altitude. If the atmosphere were always at the same temperature and pressure, such an instrument would read elevations accurately at all times. Obviously, such an instrument will be in error every time the temperature or barometric pressure changes. Modern altimeters are designed to be set by hand to compensate for errors caused by variations in local barometric pressure. The setting number for correction of a station, called the "altimeter setting," is given in the teletype report immediately following the wind data. When the altimeter is set by this number, it will show the correct elevation above sea level when landing at that field. The setting applies only to that field from which the report was sent. The latest correct altimeter setting should be obtained for each field at which it is desired to land. The setting number is in inches of mercury and averages about 29.92. As with barometric pressure, only the last three digits of the complete number are sent, the decimal point being left out. The following examples illustrate how to decode altimeter setting reports:

Report	*Setting*
(1) 990	29.90 inches of mercury.
(2) 895	28.95 inches of mercury.
(3) 045	30.45 inches of mercury.

e. Additional remarks.—(1) Often there is some special weather information which the weather observer wishes to send in the report in addition to that provided for in the regular code. In this case remarks are made at the end of the report in standard abbreviations and symbols. A few of the most important common abbreviations are listed below:

ALT	Altitude
APOBS	Airplane weather observations
ARV	Arrive
BINOVC	Break in overcast
BRK	Break
BRONO	Broadcast not operating
BROOK	Broadcast operating normally
CFR	Contact flight rule
CHG	Change
CIG	Ceiling

CLD	Cloud
CLR	Clear
CU	Cumulus (cloud)
DRZL	Drizzle
ETA	Estimated time arrival
FANOT	Fan-type marker not operative
FCST	Forecast
GNDFG	Ground fog
HZY	Hazy
ICG	Icing
IFR	Instrument flight rule
IOVC	In overcast
IPV	Improve
LTNG	Lightning
MDT	Moderate
MSL	Mean sea level
MSTK	Mistake
NOOPV	Not operative
OBSC	Obscure
OTP	On top
OVC	Overcast
OVR	Over
PCPN	Precipitation
PIBAL	Pilot balloon sequence reports (upper winds)
PIREPS	Pilot reports
QTR	Quarter
QUAD	Quadrant
RAGOK	Radio range operating normally
RAOBS	Radio meteorological soundings
RANOT	Radio range reported as unreliable
RGD	Ragged
RNWY	Runway
RTE	Route
SCTD	Scattered
SNW	Snow
SQAL	Squall
STM	Storm
STN	Station
THD	Thunderhead
THDR	Thunder
THK	Thick
THN	Thin

TLTP	Teletype
TMP	Temperature
TOVC	Top of overcast
TSTM	Thunderstorm
TURBT	Turbulent
UNSTDY	Unsteady
VSB	Visible
VSBY	Visibility
WND	Wind
WB	Weather Bureau
XLNT	Excellent
XTSV	Extensive
ZONOT	Station location marker, ultra high frequency not operating.

(2) The above short list includes many of those abbrevations commonly found in weather reports. Many others are used, but they are usually more obvious and can be translated at sight. The following examples illustrate the use of abbreviations in weather remarks:

PIREPS ICG 15–75 N FW 55–80 MSL	Pilot reports ising 15 to 75 miles north of Fort Wayne at 5,500 to 8,000 feet above mean sea level.
LTNG NW	Lightning to the northwest.

11. Decoding of complete reports.—*a. Solved examples.*—The following teletype reports have been decoded as examples for the student:

(1) SA N SPL 0535P 5 ⊕ 2L−K− 015/42/42→ 6 ↑ 0530P−/952

Interpretation: Seattle, instrument conditions, special report, 5:35 AM Pacific War Time, ceiling 500 feet, overcast 2 miles visibility, light drizzle, light smoke, pressure 1,001.5 millibars, temperature 42° F., dew point 42° F., wind west at 6 miles per hour, mild wind shift from the south at 5:30 AM Pacific War Time, altimeter setting 29.52 inches of mercury.

(2) BU X 00FF 125/54/54↖ 4/989

Interpretation: Burbank, restricted for landing and take-off, ceiling zero, visibility zero, dense fog, pressure 1,012.5 millibars, temperature 54° F., dew point 54° F., wind southeast at 4 miles per hour, altimeter setting 29.89 inches of mercury.

(3) PH X 70⦷ / ⦷1/2BN+ 109/92/70↗23+/982

Interpretation: Phoenix, restricted for landing and take-off, ceiling 7,000 feet, high broken, low broken clouds, visibility ½ mile, thick blowing sand, pressure 1,010.9 millibars, temperature 92° F., dew point 70° F., wind southwest 23 miles per hour with strong gusts, altimeter setting 29.82 inches of mercury.

b. Unsolved examples.—The student should decode the following reports for practice:

(1) NA C E15 ⊕⦷5K– 217/40/30↘20/016/CIG RGD

(2) KT E8⊕3TR—F—125/53/51→↗12/989/T MVG NE OCNL R+

(3) LY SPL E50⦷/⦷GR– 122/60/57↑18/988/FEW 20⦶ RANOT

(4) RA C E18⊕/⦷ 115/62/57↑↗13/986

(5) SH C E12⦷⦷ 163/72/60→↗22/000

(6) CS C SPL E25⦷⦷RW– 163/71/62↑↗13/000

(7) JUN C ○ 159/68/34→17/999

(8) OR C –⦷/22⦶ 185/78/66→↗10/001

(9) BZ 15⦷5⦶11/4TRAP– 002/42/40↘12–/952

(10) LG X 2⊕1/5ZL+F+ 299/30/30→3/050/PIREPS TOVC TN 80 MSL

(11) RK N ○21/21F– 120/0/–3→2/998

c. Symbol weather reports.—See chart at back of manual.

SECTION III

WEATHER MAPS

12. General.—The Army, the Navy, and the Weather Bureau maintain many observation stations all over the United States. Every 6 hours these stations make weather observations and send in their reports. These reports are made in a special number code and sent over teletype circuits to centers where weather forecasts are made. (Forecasting service is maintained at all important military and civil airfields and in most large cities.) The information received in these reports is plotted directly on a large map of the country, the information from each station being written around a small circle printed on the map in the position of the reporting station. The map after plotting shows the weather information for the entire country. A frontal analysis (fronts will be taken up in a later weather course) is then

made, and isobars are then drawn which show in picture form the distribution of barometric pressure over the area. Regions of active weather are colored. After completion, the map shows the weather situation in each part of the country; this is of considerable aid to both the forecaster and the pilot.

13. Placement of data around station circle.—*a. Example of plotted station report.*—Figure 2 shows the position of each item of information as it is plotted around the station circle, and also an example of a report which might be found on a map. So many stations are usually plotted that space is limited. For this reason plotting on actual working maps is done in very small figures made with a fine pen.

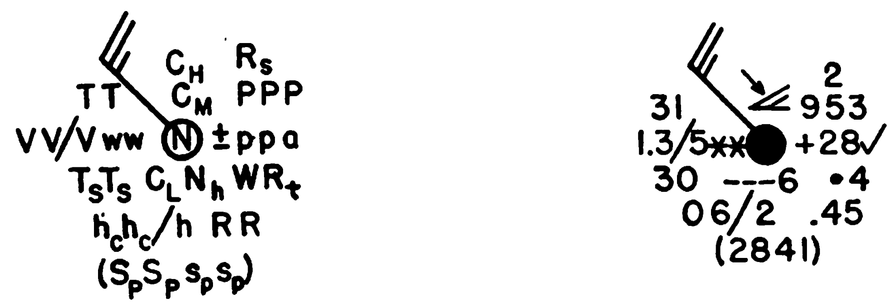


FIGURE 2.—Station circle with key showing entries of weather data and example.

b. Explanation of entries.—The entries which are of importance to the air crew members are all grouped in the central and left portion of the station report. They are as follows:

(1) —Wind direction and speed. Direction is indicated by a portion of a wind arrow drawn with the station circle as its head. The direction is that from which the wind is blowing. These wind arrows are oriented on the weather map with respect to the lines of latitude and longitude correct to 16 points of the compass. The speed is indicated by the number of full and half barbs attached to the wind arrows. Figure 3 gives the speed intervals represented by the various barb entries. Approximately, 1 full barb equals 10 miles per hour. The sample report shows the wind to be blowing from the northwest, with a speed of between 19 and 24 miles per hour.

(2) N—Sky coverage. The station circle itself is shaded to show the amount of the sky that is covered with clouds. See figure 4 at back of manual for amount represented by each type of shading. The sample report shows the sky to be overcast or more than nine-tenths covered with clouds.

(3) C_H, C_M, C_L—Form of high, middle, and low clouds, respectively. See figure 4 for the interpretation of the various cloud symbols. Direction (8 points of the compass) from which the clouds are moving is indicated by a small arrow near the cloud symbol. A small "c" stands for calm, and a small "u" represents unknown or variable direc-

tion. The sample report shows thick altostratus or nimbostratus moving from the northwest and low clouds of bad weather.

(4) TT—Temperature, in degrees Fahrenheit in English-speaking countries and ships, and degrees centigrade elsewhere.

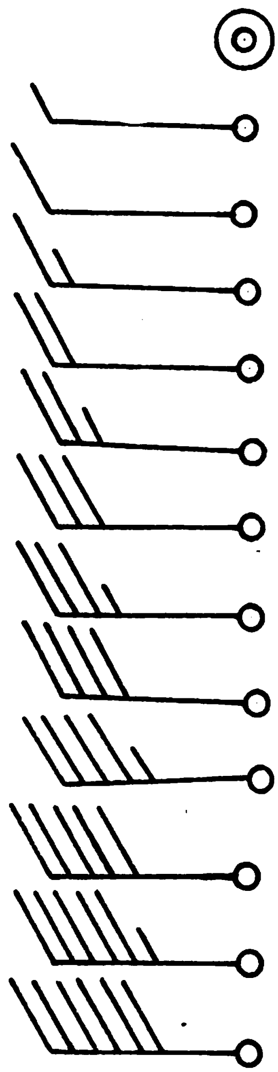
(5) VV—Visibility in miles. Sample report shows the visibility to be 1.3 miles.

(6) V—Code figure for visibility. See Code Table 53 of Weather Bureau's "Code Tables for New 1942 Weather Code" for intervals of visibility represented by code figures. Code figure "5" on the sample report shows the visibility to be between $1\frac{1}{4}$ and $2\frac{1}{2}$ miles.

(7) ww—Present weather. See figure 4 for meanings of the principal map symbols. The sample report shows continuous light snow to be occurring.

(8) T_sT_s—Dew point, in same units as temperature.

ON MAP



BEAUFORT	MPH
0	0–1
1	1–3
2	4–7
3	8–12
4	13–18
5	19–24
6	25–31
7	32–38
8	39–46
9	47–54
10	55–63
11	64–75
12	Over 75

FIGURE 3.—Speed of winds as indicated by arrow tail barbs.

(9) h_ch_c—Height of the ceiling in hundreds of feet. This entry will always be the height of the ceiling in hundreds of feet except that the entry "U" indicates an unlimited ceiling (10,000 feet or higher, or scattered clouds). The sample report entry of "06" indicates a ceiling of 600 feet.

(10) h—Code figure for height of lower clouds. For height intervals represented by the various code figures, see Code Table 54 of Weather Bureau's "Code Tables for New 1942 Weather Code." The sample report entry of "2" shows the height of lower clouds to be between 328 and 655 feet.

14. Coloring of weather areas on weather map.—*a. Precipitation areas.*—(1) Areas of continuous precipitation are colored in with solid green.

(2) Areas of intermittent precipitation are covered with parallel green lines.

(3) Areas where showers, sleet, or freezing drizzle are occurring are indicated by appropriate symbols for the particular phenomenon drawn in green scattered over the area.

b. Hazards to aviation.—(1) Areas closed in by fog are shaded in yellow.

(2) Regions of thunderstorms and drifting snow are emphasized by drawing a large symbol in green.

15. Isobars.—*a.* An isobar is a line connecting points of equal pressure. By drawing them on the weather map, the forecaster is able to see at a glance the regions of high and low pressure and, by comparing a sequence of maps, to observe their movement. They outline pressure areas just as contour lines outline terrain.

b. On Army weather maps, isobars are drawn at 3-millibar intervals through all pressures which are divisible by 3. Thus, isobars are drawn at such pressures as 999, 1,002, 1,005, 1,008, * * * 1,020, 1,023, etc., millibars. On large-scale local maps they may be drawn for every 1 or 2 millibars.

SECTION IV

WINDS ALOFT

16. General.—The direction and speed of winds in the upper atmosphere are measured by following the motion of a balloon as it rises to high levels. The balloon used for this purpose is inflated so that it will lift a standard weight. The weight is removed and

the balloon released. With proper inflation it will rise at approximately a known rate of speed. By simply noting the time elapsed after release, the height of the balloon may be calculated at any time. An instrument called a theodolite is used to measure the angular position of the balloon during its ascent. It is a form of telescope similar to the transit used by civil engineers. Both the angular direction from south and the angular elevation of the balloon from the horizon may be measured. With this information the actual position of the balloon in the sky may be calculated by means of trigonometric formulas. In actual cases, tables especially prepared for this purpose are used which simplify the calculations. A diagram of the path of the balloon across the earth is plotted on a special plotting board. The speed of the wind is indicated by the distance traveled in a short interval of time and the direction of the wind is the direction of the path of the balloon. Calculations are prepared for the direction and speed of the wind at each 1,000-foot level and this information is sent out in code over the teletype networks. The code for reporting upper wind information is explained in paragraph 17. The balloons used in making these observations are called pilot balloons and teletype reports of upper winds are abbreviated "pibals."

17. Teletype report of winds aloft.—*a. Standard groups.*—A report of the upper winds from any one observation station consists entirely of numbers (except for the designation of the station making the report) arranged in groups alternately of four and five digits each. The complete report might be represented by symbols as below:

IIEE 0ddvv ddvv 2ddvv ddvv 4ddvv ddvv 6ddvv ddvv 8ddvv ddvv 0ddvv ddvv 2ddvv 4ddvv 5ddvv 0ddvv 5ddvv 0ddvv ------

b. Explanation of symbols.—(1) The observation station call letters will be the first in the report and are represented above by the symbols II.

(2) The time of the observation to the nearest whole hour Eastern War Time immediately follows the station designator in the first groups and is represented above by the symbols EE.

(3) The digits 0, 2, 4, 6, etc., at the beginning of each five-digit group indicate the altitude of the level at which the wind is being reported, as shown in the accompanying table. The four-digit groups represent the intermediate 1,000-foot altitudes (1,000, 3,000, 5 000, etc.), according to their position in the report. Above 15,000 feet

reports are made for each 5,000 feet. These are reported as five-digit groups.

0	Surface at elevation of station
2	2,000 feet above sea level
4	4,000 feet above sea level
6	6,000 feet above sea level
8	8,000 feet above sea level
0	10,000 feet above sea level
2	12,000 feet above sea level
4	14,000 feet above sea level
5	15,000 feet above sea level
0	20,000 feet above sea level
5	25,000 feet above sea level
0	30,000 feet above sea level

Though the same digit is sometimes used for more than one level, the position of the group it heads in the report will indicate which level is intended. If the station making the report is at some elevation above sea level, the first group will still be headed by a 0 and will represent the surface wind. The remainder of such a report will follow the above outline with those elevations lower than the station being omitted.

(4) The symbols dd, wherever found, represent the direction of the wind at that level. This direction is indicated in hundreds and tens of degrees (units omitted), measured clockwise from the north. 00 represents a calm (no wind), 09 represents a 90° or east wind, 18 represents a 180° or south wind, 27 represents a 270° or west wind, and 36 represents a 360° or north wind.

(5) The symbols vv represent the speed of the wind in whole miles per hour. If the speed is over 100 miles per hour, only the tens and units digits are used, and the corresponding dd is increased by 50. If the velocity is 200 miles per hour or greater, dd and vv are separated by a slant mark as 8dd/vv.

c. Example.—The following example will illustrate the decoding of a wind aloft report:

Report: CX11 02015 2017 82135 2250 02273 2381 22397 2499 47503.

Decoded: Cheyenne 1100 AM Eastern War Time (Elevation 6,133 feet)

Surface wind	200°	15 mph
7,000-foot wind	200°	17 mph
8,000-foot wind	210°	35 mph
9,000-foot wind	220°	50 mph

10,000-foot wind ---------	220°	73 mph
11,000-foot wind ---------	230°	81 mph
12,000-foot wind ---------	230°	97 mph
13,000-foot wind ---------	240°	99 mph
14,000-foot wind ---------	250°	103 mph

[A. G. 062.11 (1-12-43).]

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:

J. A. ULIO,
Major General,
The Adjutant General.

DISTRIBUTION:

R and H 1 (2); IBn 1 (10).
(For explanation of symbols see FM 21-6.)

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